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(54) **IMAGE FORMING APPARATUS, IMAGE FORMATION PROCESS UNIT, AND DEVELOPING UNIT**

(75) Inventors: **Hiroki Mori**, Nagoya (JP); **Mitsuru Horinoe**, Aichi-ken (JP); **Yukiko Nakaya**, Konan (JP); **Yuichi Matsushita**, Nagoya (JP)

(73) Assignee: **Brother Kogyo Kabushiki Kaisha**, Nagoya-shi, Aichi-ken (JP)

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(51) **Int. Cl.**
G03G 15/08 (2006.01)

(52) **U.S. Cl.** **399/103**; 399/222

(58) **Field of Classification Search** 399/103, 399/222

See application file for complete search history.

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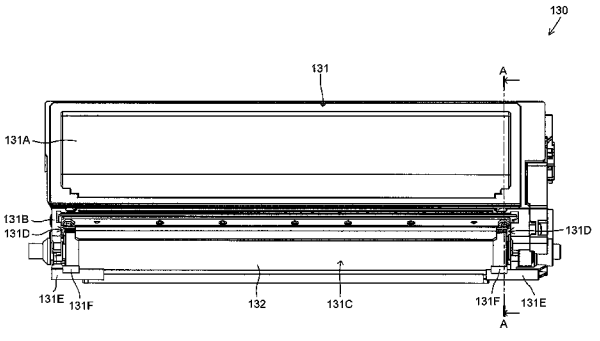
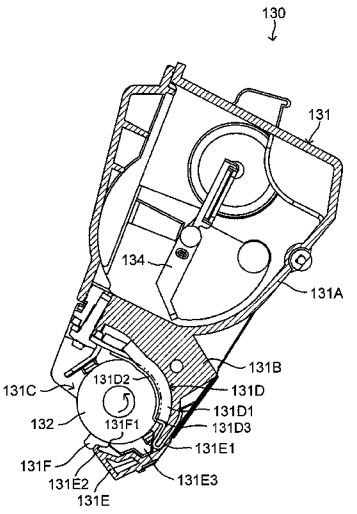
Primary Examiner — David M Gray
Assistant Examiner — Geoffrey T Evans
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

An image forming apparatus includes a main body, image formation units disposed in the main body, a moving member disposed in the main body, the moving member including a surface facing each image formation unit, a pair of first stoppers disposed in each image formation unit, and a pair of second stoppers disposed in the main body in correspondence with each image formation unit, each second stopper being configured to prevent the developer on the moving member from entering the image formation unit.

17 Claims, 8 Drawing Sheets





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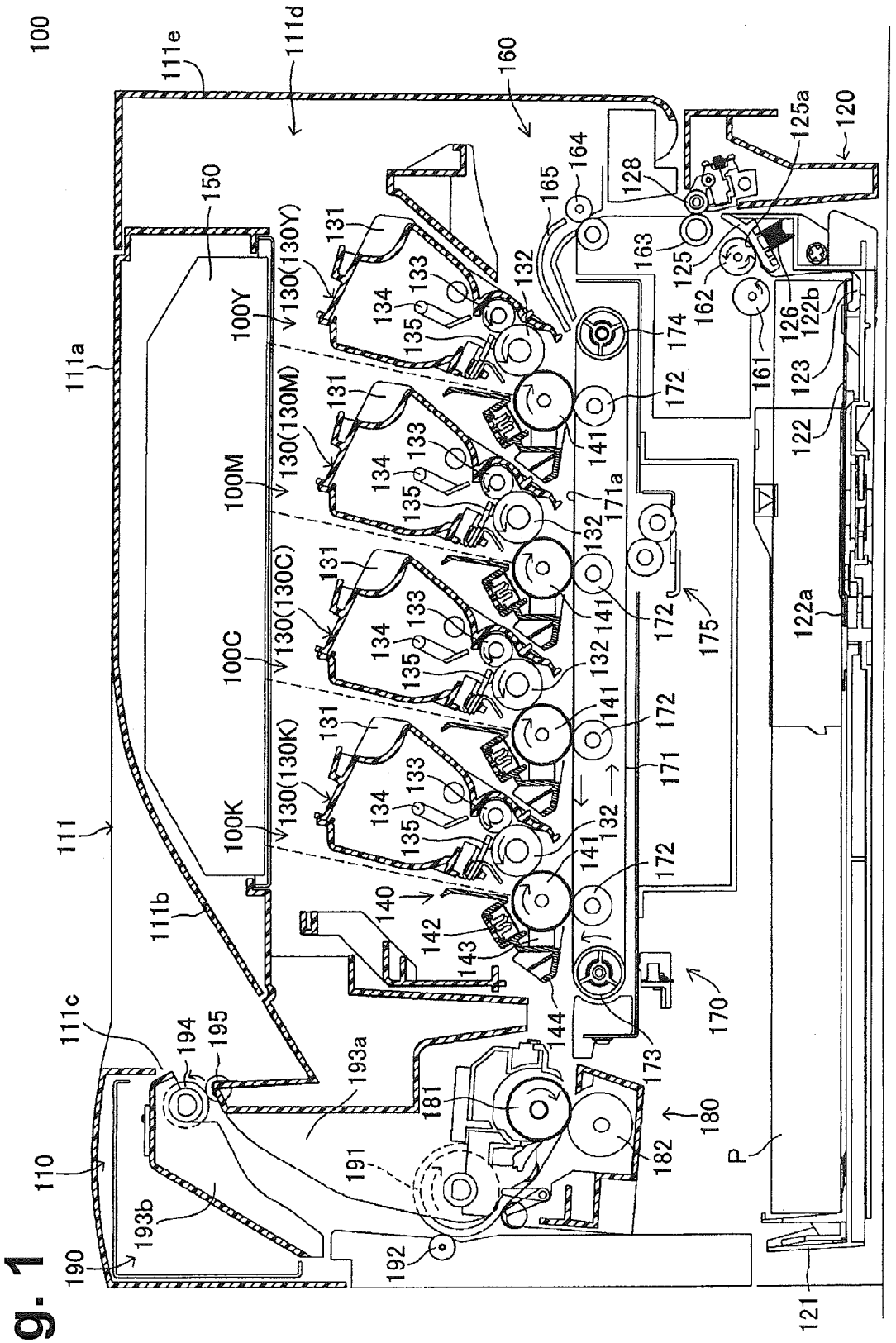
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131
132
133
134
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164
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163
125
162
126
122b
161
123
122
172
174
141
171a
100M
130(130M)
100C
130(130C)
100K
130(130K)
111
111b
140
142
143
144
170
175
122a
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111c
194
195
193a
181
180
182
P
110
193b
191
190
192
121

Fig. 1

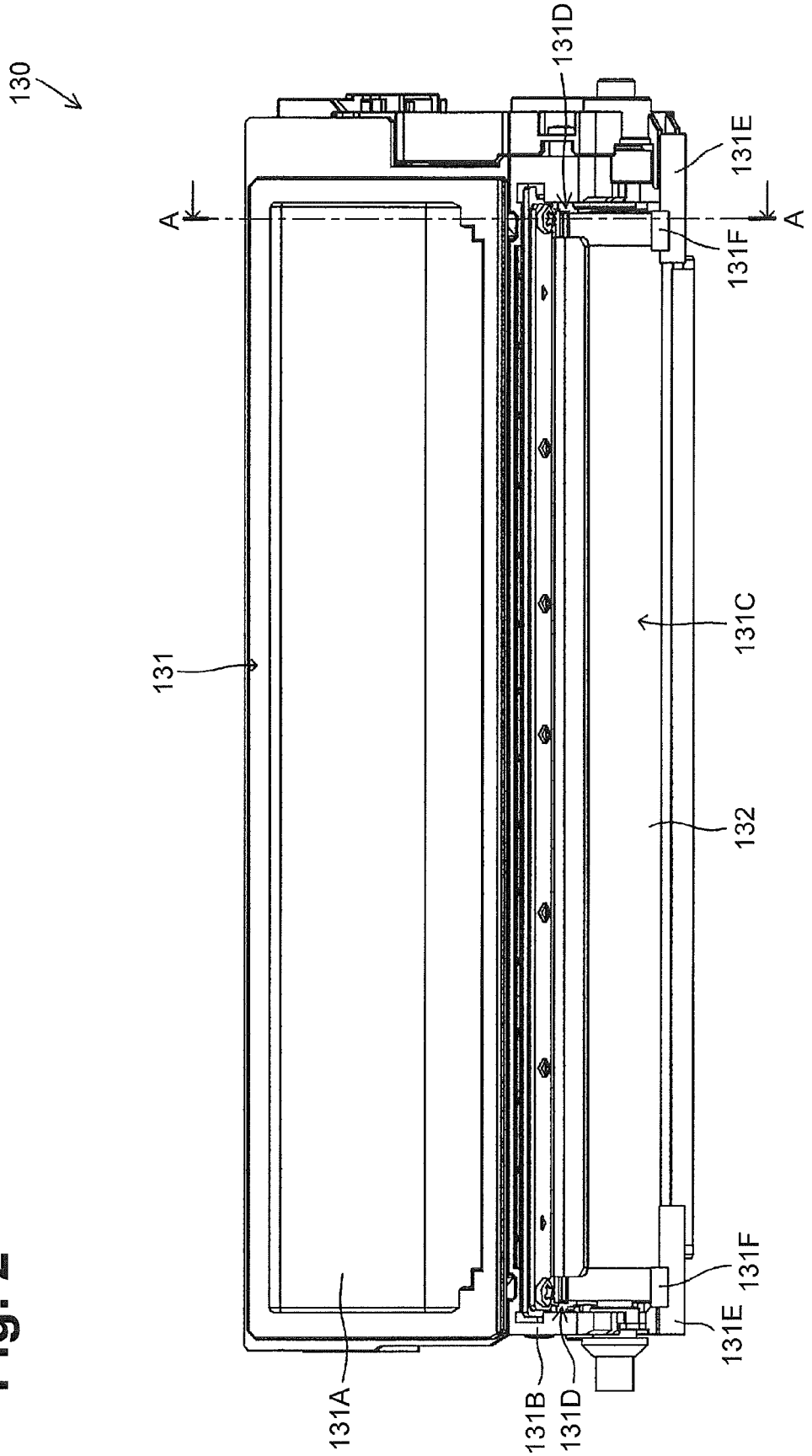
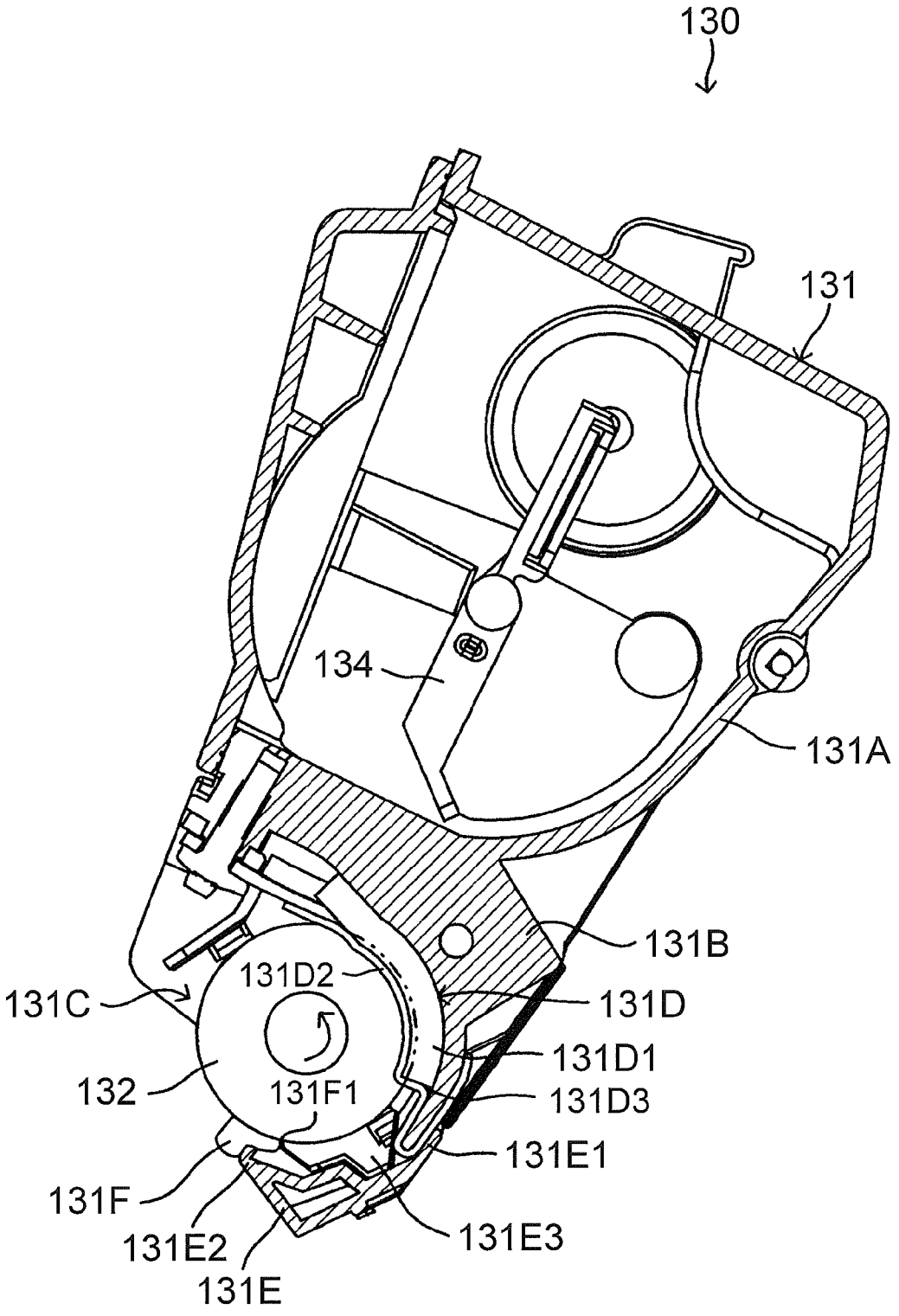


Fig. 2

Fig. 3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134
131A
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131F
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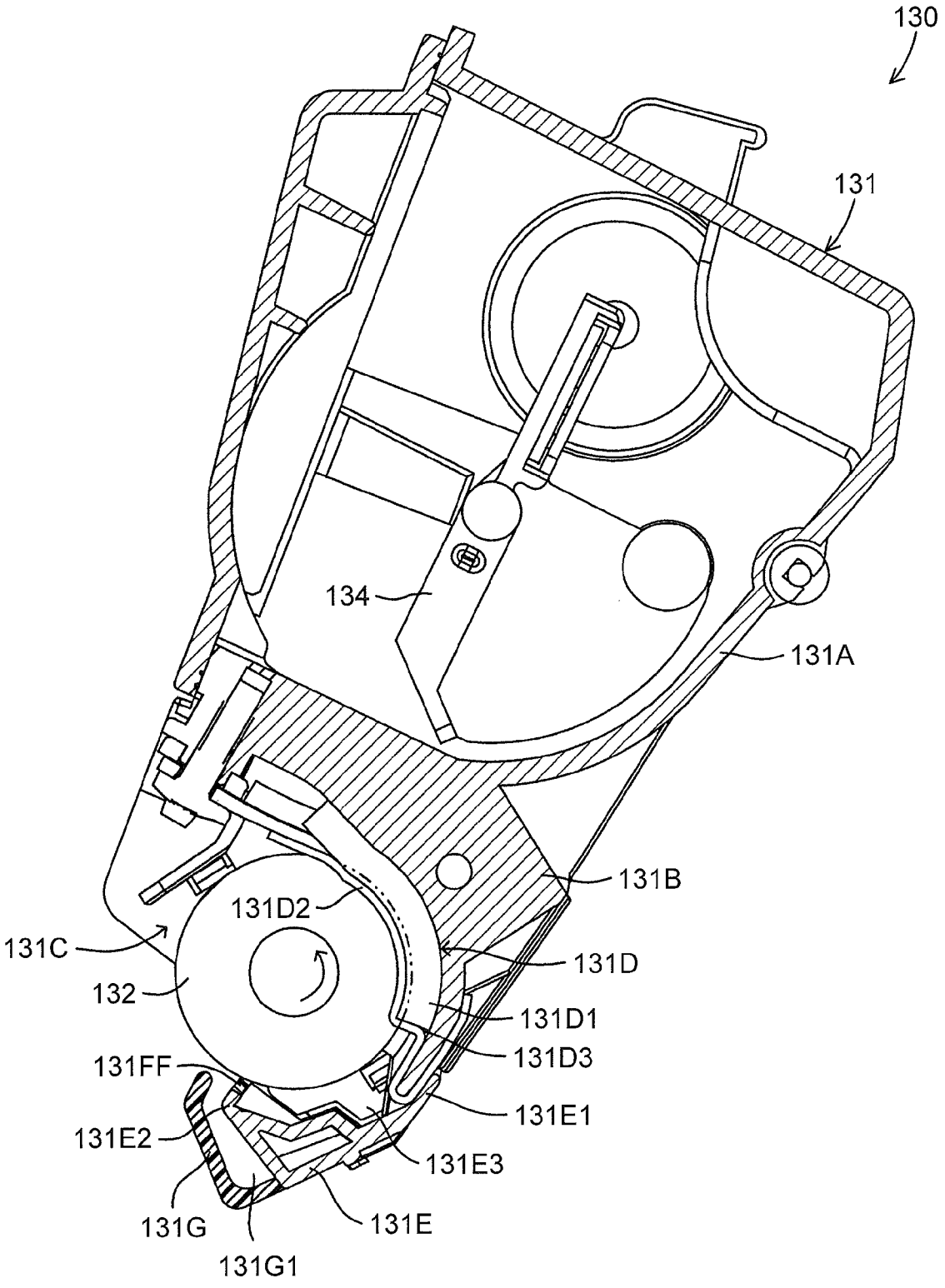
131E3
131E

Fig. 4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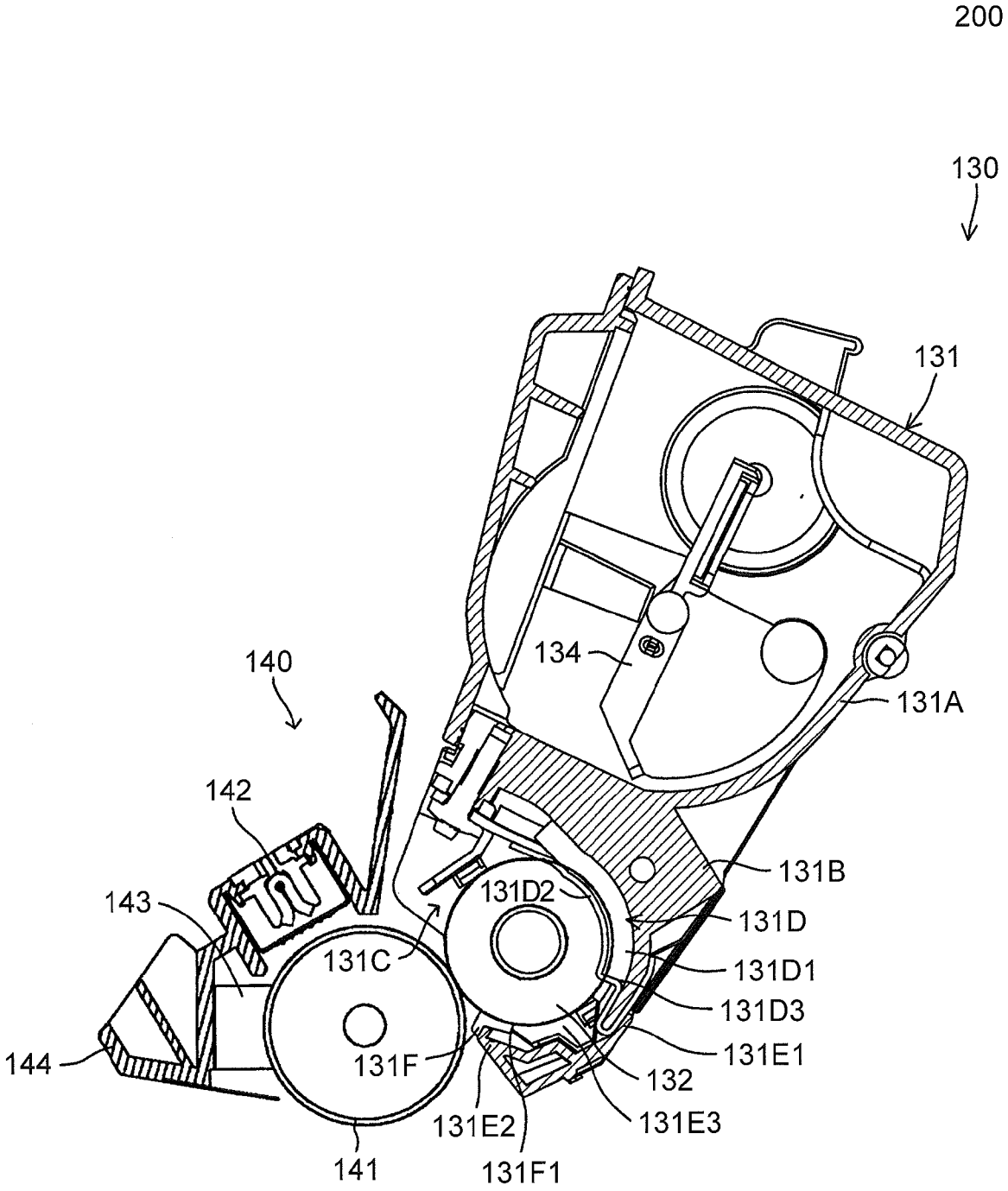
131G
131E
131G1

Fig. 5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131
134
131A
140
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131B
143
131D2
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131D1
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131F
132
131E3
131E2
141
131F1

Fig. 6

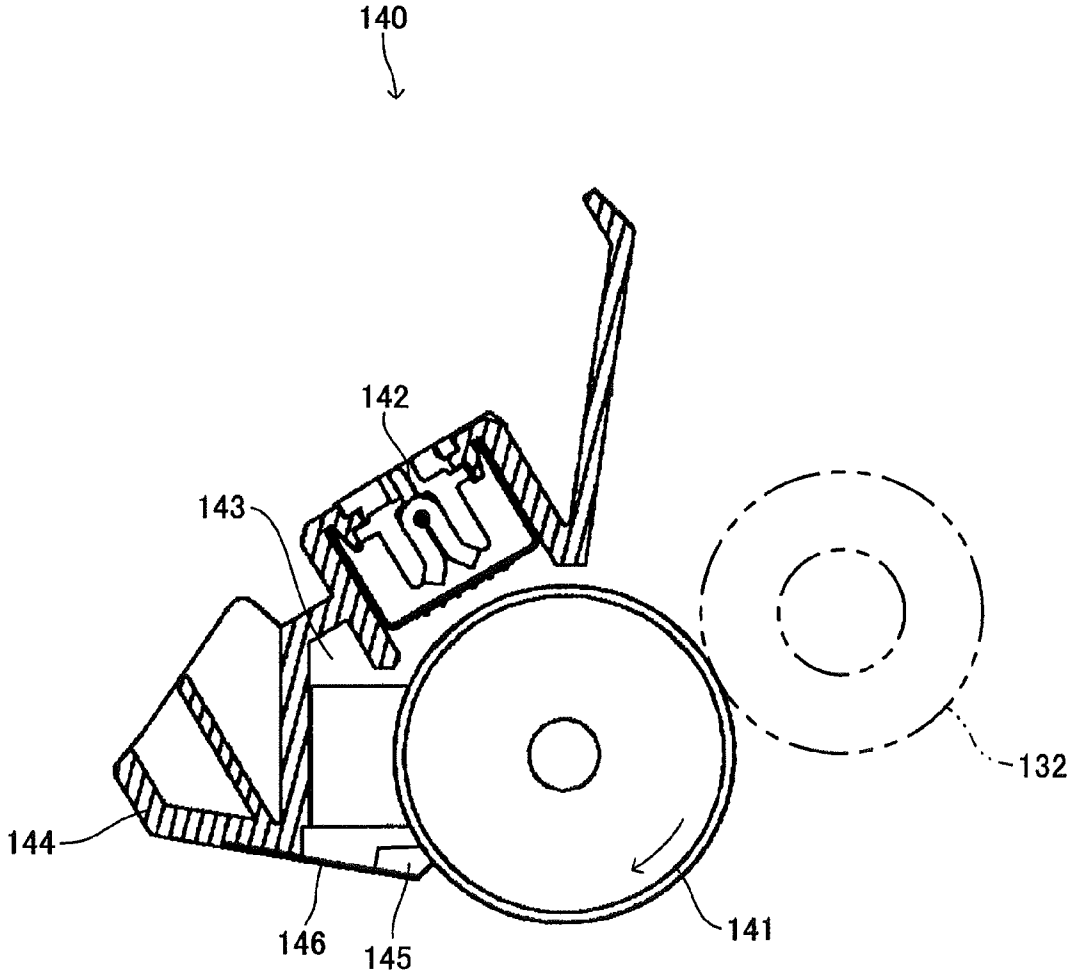
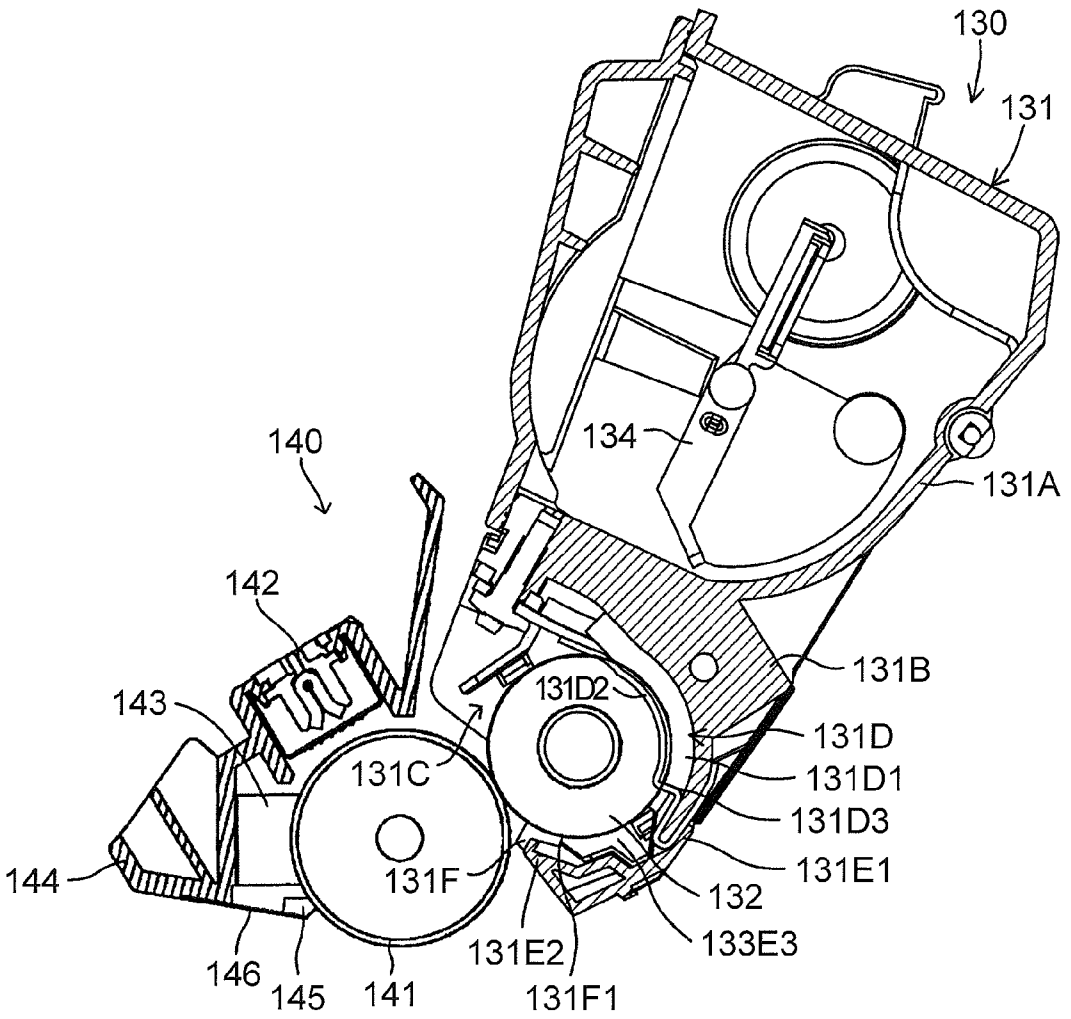


Fig. 7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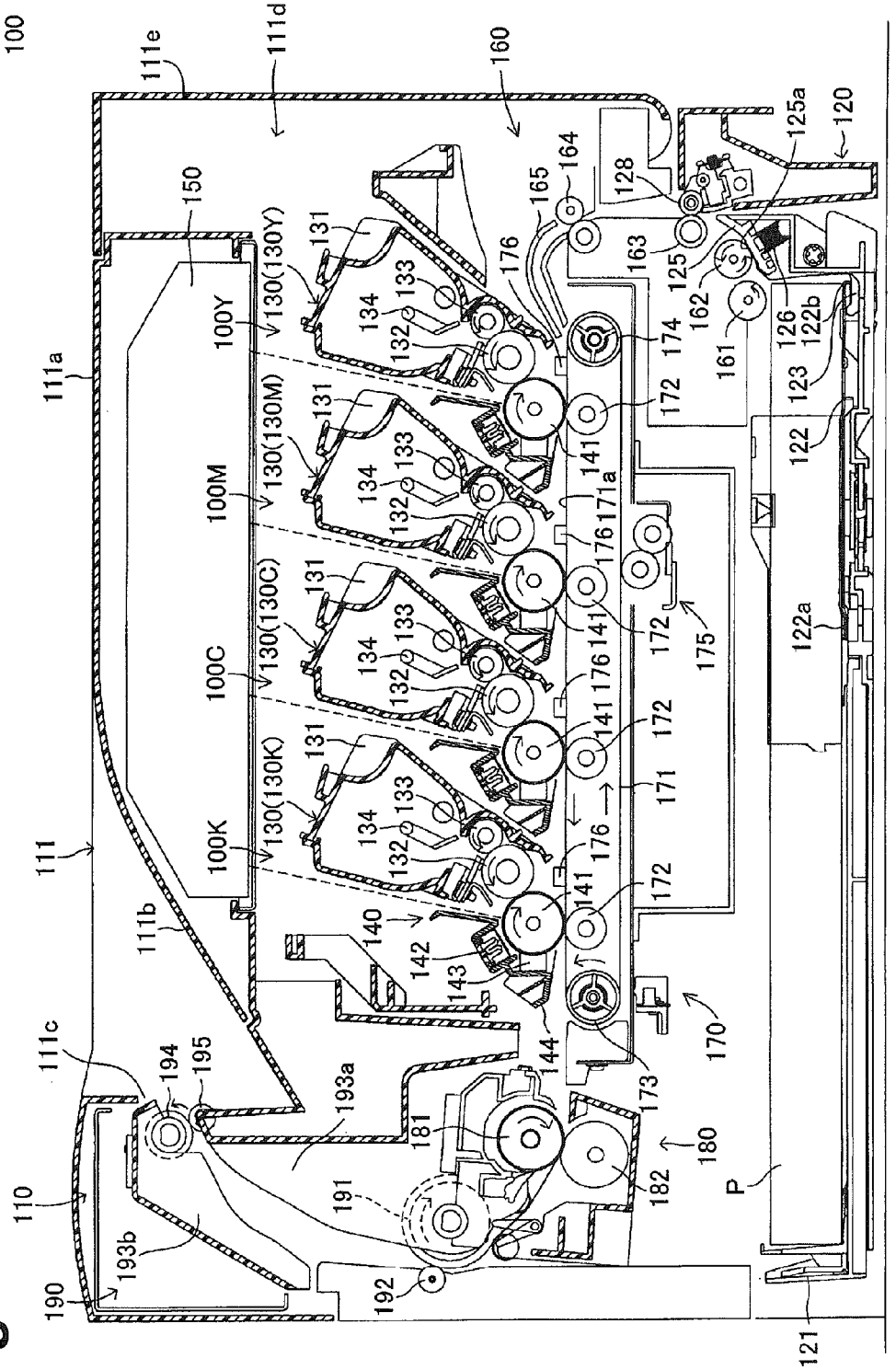
133E3
131E2
146
145
141
131F1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100C
100K
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111b
111c
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193b
193a
194
195
191
192
181
182
180
P
170
173
144
140
142
143
130(130Y)
130(130M)
130(130C)
130(130K)
131
132
133
134
141
171a
171
172
174
175
176
163
164
165
128
125
125a
120
162
161
126
122b
123
122
122a
121

Fig. 8

IMAGE FORMING APPARATUS, IMAGE FORMATION PROCESS UNIT, AND DEVELOPING UNIT

This application claims priority from Japanese Patent Application No. 2005-281146 filed on Sep. 28, 2005, the entire subject matter of which is incorporated herein by reference.

FIELD OF THE INVENTION

Aspects of the invention relate to image forming apparatuses configured to form images on a recording medium using a powder-type developer.

BACKGROUND

A developing unit is contained in image forming apparatuses. The developing unit contains powder-type developer or toner. A developing roller is rotatably supported in a body casing of the developing unit. The developing roller is configured to have a cylindrical shape and hold the developer on a circumferential surface thereof. The developing roller is disposed such that a part of the circumferential surface is exposed external to the developing unit across its full length.

The developing unit is configured to develop an electrostatic latent image formed on a circumferential surface of a photosensitive member by facing the circumferential surface of the developing roller and the circumferential surface of the photosensitive member while rotating the developing roller.

A developing unit configured to be received in and removed from a main body of the image forming apparatus (or a developer cartridge) is known. As to the developer cartridge, disclosed are various kinds of configurations to prevent leakage of the developer from a gap between each end portion of the developing roller and the opening during the rotation of the developing roller.

For example, Japanese Laid-Open Patent Publication No. 2001-5287 discloses a developing unit in which side seals are provided to prevent leakage of the developer. The side seals are disposed to slidingly contact both ends of the circumferential surface of the developing roller, thereby preventing the developer from leaking from the gaps between each end of the developing roller and the opening.

Japanese Laid-Open Patent Publication No. 2001-60040 (corresponding to U.S. Pat. Nos. 6356723 B1 and 6496669 B2) discloses a developing cartridge in which safeguard members are provided in addition to the side seals. The safeguard members are disposed on both ends of the opening in which the developing roller is rotatably disposed, with respect to its length. According to this configuration, if a small amount of developer leaks from a sliding portion between each end portion of the developing roller and the side seal, the developer can be received by the safeguard member and thus prevented from leaking outside the developer cartridge.

SUMMARY

Aspects of the invention provide a color image forming apparatus that can prevent a chain reaction of sealing defects between developing units, an image formation process unit used for an image formation process in the image forming apparatus, and the developing units used for developing process in the image forming apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the invention will be described in detail with reference to various example structures and the following figures, wherein:

FIG. **1** is a sectional view showing an internal structure of a color laser printer according to an illustrative aspect of the invention;

FIG. **2** is a plan view of a developing unit shown in FIG. **1**;

FIG. **3** is a sectional view of the developing unit taken along the line A-A of FIG. **2**;

FIG. **4** is a sectional view of a developing unit according to another aspect;

FIG. **5** is a sectional view of a structure of a process cartridge according to another aspect;

FIG. **6** is a sectional view of a structure of a drum unit according to another aspect;

FIG. **7** is a sectional view of a structure of a process cartridge according to another aspect; and

FIG. **8** is a sectional view showing an internal structure of a color laser printer according to another aspect.

DETAILED DESCRIPTION

A first example according to aspects of the invention will be described with reference to the accompanying drawings.

A brief overview of a configuration of a color laser printer **100** will be described with reference to FIG. **1**. In FIG. **1**, a right side is referred to as a front side of the color laser printer **100**, and a left side is referred to as a back side of the color laser printer **100**. In addition, a direction from the top to the bottom is referred to as a height direction or vertical direction of the laser printer **100**, a direction from the right to the left is referred to as a front-back direction of the color laser printer **100**, and a direction perpendicular to the sheet of FIG. **1** is referred to as a width direction of the color laser printer **100**.

In the color laser printer **100**, a yellow image formation portion **100**Y, a magenta image formation portion **100**M, a cyan image formation portion **100**C, and a black image formation portion **100**K are accommodated in a main body **110**. The yellow image formation portion **100**Y, the magenta image formation portion **100**M, the cyan image formation portion **100**C, and the black image formation portion **100**K are arranged in this order in the front-back direction from the front side to the back side.

The main body **110** is covered with a body casing **111** made of a synthetic resin and having a box shape. An ejection tray **111***b* is formed on a top surface **111***a* of the body casing **111**. The ejection tray **111***b* is configured to receive a sheet P ejected from an ejection port **111***c*, which is formed in an upper portion on the back side of the body casing **111**. A front-side opening **111***d* is formed on the front side of the body casing **111**. The front-side opening **111***d* is opened by opening a front cover **111***e* toward the front side so that maintenance of components disposed inside, such as the yellow image formation portion **100**Y, can be performed. The front cover **111***e* is pivotable about its lower end portion between open and closed positions.

A sheet supply cassette **120** is detachably attached to a bottom portion of the main body **110**. The sheet supply cassette **120** is configured to support a stack of sheets P (recording media) therein.

A sheet pressing plate **122** on which sheets are loaded is disposed inside a cassette case **121** which contains the sheet supply cassette **120**. The sheet pressing plate **122** is pivotable on a pressing plate rear end portion **122***a*, which is disposed on the back side, so that a pressing plate front end portion **122***b* vertically swings as a free end. A pressing plate raising lever **123** is disposed under the pressing plate front end portion **122***b* so as to urge it upward.

A separation pad **125** is disposed near the front-side end of the cassette case **121** and on a downstream side of the pressing plate front end portion **122***b* in a sheet feeding direction. A separation surface **125***a* is formed on an upper surface of the separation pad **125**. A leading end of a sheet P being fed from

the cassette case **121** in the sheet feeding direction contacts the separation surface **125***a*. The separation surface **125***a* is made of a material having a higher coefficient of friction than that of paper, such as a rubber. The separation pad **125** is urged upward by a separation pad urging spring **126**.

A pinch roller **128** is disposed on an upper end of the cassette case **121** on the front side and on a downstream side of the separation pad **125** in the sheet feeding direction. The pinch roller **128** is rotatably supported by the cassette case **121**.

Inside the main body **110** and above the sheet supply cassette **120**, developing units **130** are detachably mounted. The developing units **130** include a yellow developing unit **130**Y, a magenta developing unit **130**M, a cyan developing unit **130**C, and a black developing unit **130**K, which are arranged in this order from the front side of the color laser printer **100** toward the back side. The yellow developing unit **130**Y contains yellow powder toner, the magenta developing unit **130**M contains magenta powder toner, the cyan developing unit **130**C contains cyan powder toner, and the black developing unit **130**K contains black powder toner.

Each developing unit **130** includes a developing unit case **131**, a developing roller **132**, a supply roller **133**, an agitator **134**, and a blade **135**.

The developing unit case **131** is configured to support the developing roller **132**, the supply roller **133**, the agitator **134**, and the blade **135**, and to hold toner to develop an electrostatic latent image.

The developing roller **132** is made of rubber, and is rotatably supported by the developing unit case **131**. The supply roller **133** is made of a sponge material, and is rotatably supported by the developing unit case **131**. The developing roller **132** and the supply roller **133** are disposed in parallel and contact each other. The developing roller **132** and the supply roller **133** are configured to be rotated in a direction of the arrow indicated in FIG. **1**, to charge toner at their contact portion, and to cause the charged toner to be carried on the circumferential surface of the developing roller **132**.

The agitator **134** is configured to agitate toner in the developing unit case **131**, and feed toner toward the supply roller **133**. The agitator **134** is rotatably supported by the developing unit case **131**.

The blade **135** is configured to regulate the amount of toner on the circumferential surface of the developing roller **132** by contacting the circumferential surface of the developing roller **132** when it is rotated in the direction of the arrow.

Drum units **140** are disposed along the front-back direction so as to face the corresponding developing rollers **132** of each developing unit **130**.

Each drum unit **140** includes a photosensitive drum **141**, a scorotron charger **142**, a drum cleaner **143**, and a drum unit frame **144**.

The photosensitive drum **141** is configured so that an electrostatic latent image is formed on its circumferential surface. The photosensitive drum **141** is disposed to face the developing roller **132** of the developing unit **130**. The scorotron charger **142** is disposed to face the circumferential surface of the photosensitive drum **141** on an upstream side of a position where the photosensitive drum **141** faces the developing roller **132** in a rotation direction of the photosensitive drum **141** (a direction of the arrow indicated in FIG. **1**, herein after referred to as a drum rotation direction). The scorotron charger **142** is configured to uniformly charge the circumferential surface of the photosensitive drum **141**. The drum cleaner **143** is disposed to face the circumferential surface of the photosensitive drum **141** on an upstream side of a position where the scorotron charger **142** faces photosensitive drum **141** in the drum rotation direction. The drum cleaner **143** is configured to clean the circumferential surface of the photosensitive drum **141** before being charged by the scorotron charger **142** along the longitudinal direction of the photosensitive drum **141** (or the width direction).

A scanner unit **150** is configured to generate and modulate a laser beam (indicated with a broken line in FIG. **1**) based on image data at a laser emitting portion (not shown), and emit the laser beam onto the circumferential surface of the photosensitive drum **141** which is charged uniformly by the scorotron charger **142**. That is, the scanner unit **150** is configured to scan the laser beam on the circumferential surface of the photosensitive drum **141** and form an electrostatic latent image on the circumferential surface of the photosensitive drum **141**.

Inside the main body **110**, a sheet feeding portion **160** for supplying a sheet P toward the developing units **130** and the drum units **140** is provided. The sheet feeding portion **160** is made up of a pickup roller **161**, a separation roller **162**, a sheet dust removing roller **163**, a feed roller **164**, and a sheet guide **165**.

The pickup roller **161** is rotatably supported in the main body **1 10**. The pickup roller **161** is configured to rotate in a direction of an arrow indicated in FIG. **1** via a power transmission mechanism provided in the main body **110**. The pickup roller **161** is disposed to contact a sheet P, which is urged upward by the pressing plate front end **122***b* of the sheet pressing plate **122** and the pressing plate lifting lever **123**, during image formation.

The separation roller **162** is rotatably supported in the main body **110**. The separation roller **162** is configured to rotate in a direction of an arrow indicated in FIG. **1** via the power transmission mechanism provided in the main body **110**. The separation roller **162** is disposed in contact with and applying pressure against the separation pad **125**.

The sheet dust removing roller **163** is rotatably supported in the main body **110**.

The sheet dust removing roller **163** is disposed ahead of the separation pad **125** in the sheet feeding direction so as to contact the pinch roller **128**. The sheet dust removing roller **163** is configured to remove foreign matter such as paper dust and dirt from a sheet P by sandwiching the sheet P being fed with the pinch roller **128**.

The feed roller **164** and the sheet guide **165** are disposed between the sheet dust removing roller **163** and the yellow image formation portion **100**Y. The feed roller **164** and the sheet guide **165** are configured to guide a sheet P past the sheet dust removing roller **163** toward between the yellow image formation portion **100**Y and a transfer portion **170**.

The transfer portion **170** is disposed inside the main body **110** and under the image formation portions **100**Y, **100**M, **100**C, **100**K. The transfer portion **170** is made up of a sheet conveyor belt **171**, transfer rollers **172**, a belt drive roller **173**, a belt support roller **174**, and a belt cleaner **175**.

The sheet conveyor belt **171** is formed as a circular belt made of a conductive plastic such as polycarbonate and polyimide, in which conductive particles, for example, carbon particles, are dispersed. The sheet conveyor belt **171** is stretched so that a conveyance-side surface **171***a*, which is an outer surface of the conveyor belt **171**, faces the photosensitive drums **141**.

The transfer rollers **172** are rotatably supported to face the respective photosensitive drums **141** via the sheet conveyor belt **171**. The transfer rollers **172** are electrically connected to an output terminal of high voltage. A bias voltage is applied between each transfer roller **172** and the corresponding photosensitive drum **141** to transfer toner on the circumferential

surface of the photosensitive drum **141** onto a sheet P being fed on the sheet conveyor belt **171**.

The belt drive roller **173** is configured to rotate in a direction of an arrow in FIG. **1** via the power transmission mechanism provided in the main body **110**. The belt drive roller **173** is disposed behind the photosensitive drum **141** facing the black developing unit **130**K, which is disposed backmost in the developing units **130**.

The belt support roller **174** is disposed before the photosensitive drum **141** facing the yellow developing unit **130**Y, which is disposed foremost in the developing units **130**. The sheet conveyor belt **171** is stretched between the belt drive roller **173** and the belt support roller **174** by a tension. When the belt drive roller **173** rotates in the direction of the arrow, the sheet conveyor belt **171** is moved around between the belt drive roller **173** and the belt support roller **174**, and the belt support roller **174** is rotated.

The sheet conveyor belt **171** is supported by the belt drive roller **173** and the belt support roller **174** so that the conveyance-side surface **171***a* is movable below the image formation units **100**Y, **100**M, **100**C, and **100**K along their arrangement.

The belt cleaner **175** is disposed under the sheet conveyor belt **171** that is stretched below the transfer rollers **172**. The belt cleaner **175** is configured to clean the conveyance-side surface **171***a* of the sheet conveyor belt **171** facing the image formation units **100**Y, **100**M, **100**C, and **100**K in the width direction.

A fixing portion **180** is disposed inside the main body **110** and downstream of the transfer portion **170** in the sheet feeding direction. The fixing portion **180** is configured to fix the toner image formed onto the sheet P. The fixing portion **180** includes a heat roller **181** and a pressure roller **182**.

The heat roller **181** includes a roller body made of a metal thin tube whose surface is mold free, and a halogen lamp set inside the roller body. The heat roller **181** is configured to rotate in a direction of an arrow in FIG. **1** via the power transmission mechanism provided in the main body **110**. The pressure roller **182** can be a silicone rubber roller disposed to press against the heat roller **181** by a pressure. The pressure roller **182** is configured to sandwich a sheet P with the heat roller **181**, rotate along with the rotation of the heat roller **181**, fix the toner image onto the sheet P, and feed the sheet P toward the ejection port **111***c*.

An ejection portion **190** is disposed backmost inside the main body **110** and above the fixing portion **180**. The ejection portion **190** is configured to eject the sheet P passing the fixing portion **180** outside the main body **110**.

The ejection portion **190** includes a feed roller **191**, a pinch roller **192**, sheet guides **193***a*, **193***b*, an ejection roller **194**, and a driven roller **195**.

The feed roller **191** and the pinch roller **192** are disposed downstream of the heat roller **181** and the pressure roller **182** in the sheet feeding direction. The feed roller **191** is supported to be rotated in a direction of an arrow indicated with a broken line in FIG. **1**. The pinch roller **192** is disposed facing the feed roller **191**. The pinch roller **192** is rotatably supported so as to follow the rotation of the feed roller **191**. The feed roller **191** and the pinch roller **192** are configured to feed the sheet P on which the toner image has been fixed toward the ejection portion **111***c* along the rotation of the feed roller **191** in the direction of the arrow indicated with the broken line in FIG. **1**.

The sheet guides **193***a* and **193***b* are formed on the downstream side of the feed roller **191** and the pinch roller **192** in the sheet feeding direction. The sheet guides **193***a* and **193***b* are configured to guide the sheet P being fed by the feed roller **191** and the pinch roller **192**, toward a contact portion between the ejection roller **194** and the driven roller **195**.

The ejection roller **194** and the driven roller **195** are disposed near the ejection port **111***c* to face the ejection port **111***c*. The ejection roller **194** is supported to be rotated in a direction of an arrow shown in FIG. **1**. The driven roller **195** is disposed facing the ejection roller **194**. The driven roller **195** rotatably supported so as to follow the rotation of the ejection roller **194**. The ejection roller **194** and the driven roller **195** are configured to eject the sheet P on which the toner image has been fixed, from the ejection port **111***c* outside the main body **110**, along with the rotation of the ejection roller **194** in the direction of the arrow indicated in FIG. **1**.

FIG. **2** is a plan view of one of the developing units **130** shown in FIG. **1**. FIG. **3** is a sectional view of the developing unit **130** taken along the line A-A of FIG. **2**. In FIG. **3**, it is assumed that the developing unit **130** is mounted in the main body **110** of the color laser unit **100** as shown in FIG. **1**.

Referring to FIGS. **2** and **3**, the developing unit **130** includes a toner containing case **131**A, and a roller support portion **131**B. The toner containing case **131**A constitutes a toner chamber in which toner is contained. Inside the toner containing case **131**A, the agitator **134** is rotatably accommodated. The roller support portion **131**B is configured to support the developing roller **132** and the supply roller **133** rotatably. The roller support portion **131**B is formed with a developing roller exposure opening **131**C. The developing roller **132** is rotatably supported at the developing roller exposure opening **131**C and disposed so that more than half of the circumferential surface of the developing roller **132** is exposed outside of the developing unit case **131**, along the longitudinal direction or the width direction, that is, the left-right direction of FIG. **2**.

As shown in FIG. **3**, a side seal member **131**D**1** and a felt member **131**D**2** are disposed in a seal portion **131**D. The seal portion **131**D is a gap formed between each end portion of the developing roller exposure opening **131**C and each end portion of developing roller **132** in the width direction. The side seal member **131**D**1** may be made of a urethane sponge having relatively high rigidity. The side seal member **131**D**1** is bonded on a surface of the developing unit case **131** (or the roller support portion **131**B) facing the seal portion **131**D. The felt member **131**D**2** can be formed of a napped felt in which a fluorine-based synthetic resin is impregnated. The felt member **131**D**2** is bonded over the entire side seal member **131**D**1**. The developing roller **132** is disposed to press against the side seal member **131**D**1** from above the felt member **131**D**2** at each end of the developing roller **132** in the width direction. Referring to a double dotted line in FIG. **3**, the side seal member **131**D**1**, the felt member **131**D**2**, and the developing roller **132** are in pressing contact with each other.

As shown in FIG. **2**, safeguard members **131**E are disposed on both ends of the developing roller exposure opening **131**C in the width direction. As shown in FIG. **3**, the safeguard member **131**E is fixed to a lower end of the roller support portion **131**B to form a lower end of the developing unit **130** when the developing unit **130** is mounted in the main body **110**. The safeguard member **131**E is configured to prevent toner from leaking outside the developing unit **130** when toner leaks from the seal portion **131**D during attachment to and detachment from the main body **110**.

Specifically, a base end portion **131**E**1** of the safeguard member **131**E is fixed to the lower end of the roller support portion **131**B so as to pinch an end of the felt member **131**D**2** against the roller support portion **131**B as shown in FIG. **3**. An end portion **131**E**2** of the safeguard member **131**E is disposed to protrude from the base end portion **131**E**1** toward an upstream side in the rotation direction of the developing roller **132** as indicated with an arrow in FIG. **3**. A hollow portion

131E3 provided between the base end portion 131E1 and the end portion 131E2 is configured to collect toner which leaks from the seal portion 131D.

As shown in FIG. 2, toner intrusion stoppers 13IF are disposed to correspond with both ends of the developing roller 132 in the width direction. As shown in FIG. 3, a toner intrusion stopper 131F is fixed to the end portion 131E2 of the safeguard member 131E.

As shown in FIG. 3, the toner intrusion stopper 131F is disposed to contact the circumferential surface of each end of the developing roller 132 by a pressure on an upstream side, in the rotation direction of the developing roller 132, at a position where the side seal member 131D1 and the felt member 131D2 are in pressing contact with the developing roller 132. A space corresponding to the hollow portion 131E3 is provided between an upstream-side end portion 131D3 of the seal portion 131D in the rotation direction of the developing roller 132 and a downstream-side end portion 13F1 of the toner intrusion stopper 131 in the rotation direction of the developing roller 132. The toner intrusion stopper 131F can be formed of a urethane sponge.

Referring to FIGS. 2 and 3, the seal portion 131D (the side seal member 131D1 and the felt member 131D2) and the toner intrusion stopper 131F are disposed to overlap each other in the width direction.

Referring to FIG. 1, an image formation operation by the color laser printer 100 will be described.

When the pickup roller 161 is rotated in the direction of the arrow, a few of sheets P loaded in the cassette case 121 are fed toward the separation roller 162. The leading ends of the sheets P are fed in between the separation roller 162 and the separation pad 125. With the rotation of the separation roller 162 in the direction of the arrow, only an uppermost sheet P is fed toward the sheet dust removing roller 163. The sheet P from which dust has been removed by the sheet dust removing roller 163 is fed toward the transfer portion 170 via the feed roller 164 and the sheet guide 165.

When the agitator 134 is rotated, toner in the developing unit case 131 is agitated, and the toner is fed toward the supply roller 133. The toner fed to the supply roller 133 is fed to the developing roller 132 with the rotation of the supply roller 133 in the direction of the arrow. The toner is frictionally charged at a position where the developing roller 132 and the supply roller 133 are in contact with each other, and adheres to the circumferential surface of the developing roller 132. The toner adhering to the circumferential surface of the developing roller 132 is regulated to a specified density and charging amount by the blade 135, and then supplied to a position where the developing roller 132 faces the photosensitive drum 141.

The circumferential surface of the photosensitive drum 141 is charged uniformly by the scorotron charger 142, and irradiated with laser light modulated according to image information. Thus, an electrostatic latent image based on the image information is formed on the circumferential surface of the photosensitive drum 141. The circumferential surface of the photosensitive drum 141, on which the latent image is formed, faces the circumferential surface of the developing roller 132, and the toner adheres to the circumferential surface of the photosensitive drum 141. Thus, the latent image on the circumferential surface of the photosensitive drum 141 is developed with the toner.

The sheet P fed to the transfer portion 170 is carried on the sheet conveyor belt 171, and fed from the front to the back (from the right to the left in FIG. 1). When the sheet P is fed between the photosensitive drum 141 and the transfer roller 172 (hereinafter referred to as a transfer area), a bias voltage is applied to the transfer area, and the toner on the circumferential surface of the photosensitive drum 141 is transferred to the sheet P.

The sheet P to which the toner has adhered in the transfer portion 170 is fed to the fixing portion 180. The sheet P is pinched and heated between the heat roller 181 and the pressure roller 182, and the toner on the sheet P is melted and fixed onto the sheet P. Then, the sheet P is ejected to the ejection tray 111*b* outside the main body 110 by the ejection roller 194.

With reference to FIGS. 1 and 3, the following description will be made as to how to prevent toner that leaks (e.g., accidentally) from an end of one developing unit 130, in the width direction, from intruding into the remaining developing units 130.

In the following description, it is assumed that toner leaks from the seal portion 131D of the developing unit case 131 of the yellow developing unit 130Y.

In this case, the leaked toner adheres to an end of the circumferential surface of the developing roller 132 in the width direction. The leaked toner adhering to the end of the circumferential surface of the developing roller 132 adheres to an end of the circumferential surface of the photosensitive drum 141 in the width direction. The leaked toner adhering to the end of the circumferential surface of the photosensitive drum 141 is fed to the transfer area with the rotation of the photosensitive drum 141 in the direction of the arrow, and adheres to an end of the sheet conveyor belt 171 or the conveyance-side surface 171*a*, in the width direction, in the transfer area.

Alternatively, the leaked toner may drop to the end of the conveyance-side surface 171*a* of the sheet conveyor belt 171 disposed under the sealed portion 131D by gravitation and deposit in the end.

The leaked toner that is deposited in the end of the conveyance-side surface 171*a* of the sheet conveyor belt 171 is fed to the transfer area of the magenta image formation portion 100M as the conveyance-side surface 171*a* is moved in the direction of the arrow. In the transfer area, the end of the conveyance-side surface 171*a* where the leaked toner is deposited faces the photosensitive drum 141, which results in the toner adhering to the end of the photosensitive drum 141.

When the toner adheres to the end of the photosensitive drum 141 in the drum unit 140 that faces the magenta developing unit 130M, the toner is fed to the magenta developing unit 130M along with the rotation of the photosensitive drum 141 in the direction of the arrow.

The toner can be partially removed by the drum cleaner 143 provided in the drum unit 140. As is well known, the seal portion 131D is formed outside an image formation area of the photosensitive drum 141 in the width direction, and an area where the leaked toner adheres is determined outside the image formation area.

The drum cleaner 143 is designed on the assumption that it removes a small amount of toner or dust that is not transferred to the sheet P in the transfer area and remains in the image formation area. It is not assumed that the drum cleaner 143 completely removes all of a relatively large amount of toner adhering to the photosensitive drum 141 (especially outside the image formation area) such as the toner leaked as described above.

Thus, it can be difficult for the drum cleaner 143 to remove the leaked toner adhering to the end of the photosensitive drum 141 from the conveyance-side surface 171*a* of the conveyor belt 171 in the transfer area (that is, the toner inversely transferred from the conveyance-side surface 171*a* to the end of the photosensitive drum 141). As a result, a part of the

leaked toner passes through the drum cleaner **143** and is fed to a position where the photosensitive drum **141** faces the end of the developing roller **143** in the magenta developing unit **130**M. In this position, the leaked toner adheres to the end of the developing roller **132** in the magenta developing unit **130**M.

In a configuration that does not include the toner intrusion stoppers **131**F, the leaked toner enters the sealed portion **131**D of the magenta developing unit **130**M.

That is, the toner goes in between the end of the circumferential surface of the developing roller **132** and the felt member **131**D**2** in the magenta developing unit **130**M, which causes a poor sealed state in the seal portion **131**D of the magenta developing unit **130**M. As a result, magenta toner leaks from the seal portion **131**D.

However, according to the above configuration, the leaked toner adhering to the end of the developing roller **132** of the magenta developing unit **130**M is removed by the toner intrusion stopper **131**F. Thus, the leaked toner can be prevented from intruding the seal portion **131**D of the magenta developing unit **130**M.

According to the above configuration, if a toner leakage happens at an end of one developing unit **130** in the width direction, the toner leakage can be prevented from bringing about a chain reaction of toner leakage at the neighboring developing unit **130**. A chain reaction of sealing trouble can be effectively contained.

While the invention has been described with reference to exemplary aspects, it is to be understood that the invention is not restricted to the particular forms shown in the foregoing exemplary aspects. Various modifications and alterations can be made thereto without departing from the scope of the invention.

While aspects of the invention are described in a color laser printer, it will be appreciated that these aspects may be applied to other image forming apparatus including, but not limited to, multi-function devices, scanners, facsimiles, copiers and the like.

The configuration of the toner intrusion stopper, which is configured to prevent toner from intruding in the seal portion **131**D of the developing unit case **131** from outside, is not limited to that shown in FIG. **3**. As shown in FIG. **4**, for example, a toner intrusion stopper **131**FF may be made of a plate member configured to scrape the leaked toner adhering to the end of the circumferential surface of the developing roller **132**. The toner intrusion stopper **131**FF is fixed to the end portion **131**E**2** of the safeguard member **131**E. When the edge of the toner intrusion stopper **131**FF contacts the end of the circumferential surface of the developing roller **132**, the leaked toner adhering thereto is scraped.

In this case, a collecting member **131***g* may be provided to collect the leaked toner scraped by the toner intrusion stopper **131**FF. The toner intrusion stopper **131**FF is fixed to the safeguard member **131**E. The collecting member **131**g is formed with a recessed portion **131***g***1**. The toner intrusion stopper **131**FF is disposed so that the recessed portion **131***g***1** is open toward a contact portion between the developing roller **132** and the toner intrusion stopper **131**FF.

According to the above configuration, if a large amount of toner leaks, a chain reaction of sealing trouble can be effectively prevented. In addition, the toner intrusion stopper **131**FF and the collecting member **131***g* are provided in the developing unit **130** that is replaceable and can be attached to and removed from the main body **110** of the color laser printer **100**. Thus, the leaked toner that is collected can be removed from the inside of the main body **110** at a specified time.

Each of the yellow image formation portion **100**Y, the magenta image formation portion **100**M, the cyan image formation portion **100**C, and the black image formation portion **100**K that are shown in FIG. **1** may be configured as a process cartridge **200** that is attachable to and detachable from the color laser printer **1** as shown in FIG. **5**. Namely, the process cartridge **200** including the developing unit **130** and the drum unit **140** may be configured to be attached to and removed from the color laser printer **1**.

In the process cartridge shown in FIG. **5**, the developing unit **130** and the drum unit **140** may be separated from each other.

As shown in FIG. **6**, the drum unit **140** may include a drum end cleaner **145**. The drum end cleaner **145** may be provided independently from a mechanism (the drum cleaner **143** in the above description) for removing toner adhering to the image formation area on the photosensitive drum **141** after toner has been transferred.

The drum end cleaner **145** is disposed in contact with the end of the circumferential surface of the photosensitive drum **141** on a downstream side of the transfer position in the rotation direction of the photosensitive drum **141**. More specifically, the drum end cleaner **145** is supported by the drum unit frame **144** via a support member **146** that is made of a flexible plate member. The drum end cleaner **145** is disposed in contact with the end of the circumferential surface of the photosensitive drum **141** on an upstream side of a position where the photosensitive drum **141** faces the scorotron charger **142**, in the rotation direction of the photosensitive drum **141**.

The drum end cleaner **145** may be disposed in contact with the end of the circumferential surface of the photosensitive drum **141** on the upstream side of a position where the drum cleaner **143** faces the photosensitive drum **141** in the rotation direction of the photosensitive drum **141**, as shown in FIG. **6**. Alternatively, the drum end cleaner **145** may be disposed in contact with the end of the circumferential surface of the photosensitive drum **141** on a downstream side of the position where the drum cleaner **143** faces the photosensitive drum **141** in the rotation direction of the photosensitive drum **141**.

The above modification may be applied to a configuration of a cleaner-less type, which omits the drum cleaner **143**.

As shown in FIG. **7**, the toner intrusion stopper **131**F may be used in conjunction with the drum end cleaner **145**. As described above, the developing unit **130** including the toner intrusion stopper **131**F and the drum unit **140** including the drum end cleaner **145** may be configured as the process cartridge **200** (FIG. **5**) that is attachable to and detachable from the main body **110** (FIG. **1**) of the color laser printer **1**.

As shown in FIG. **8**, the transfer portion **170** may include belt end cleaners **176**.

The belt end cleaners **176** are disposed between the adjacent image formation portions so as to face each end of the sheet conveyor belt **171** in the width direction. The belt end cleaners **176** are configured to remove the leaked toner adhering to the conveyance-side surface **171***a* of the conveyor belt **171**.

According to the above configuration, the leaked toner can be removed from the conveyance-side surface **171***a* of the conveyor belt **171** before the leaked toner intrudes in the neighboring image formation portion disposed on a downstream side in the rotation direction of the sheet conveyor belt **171**. Thus, a chain reaction of sealing trouble can be effectively prevented.

What is claimed is:

1. An image forming apparatus comprising:
a main body;
image formation units disposed in the main body, each image formation unit including:
a developing case extending in a first direction, the developing case being configured to hold developer therein,
a developer carrier disposed in the developing case, the developer carrier configured to rotate and hold the developer on a circumferential surface thereof, and
a pair of sealing members disposed in the developing case, each sealing member being disposed in a gap between the developing case and an end of the developer carrier in the first direction, each sealing member being configured to prevent developer from leaking outside the developing case;
a moving member disposed in the main body and including an opposing surface facing each of the image formation units, the moving member being configured to move in a second direction perpendicular to the first direction;
photosensitive members, each of which is disposed facing a corresponding developer carrier and configured to rotate and hold an electrostatic latent image on a circumferential surface thereof,
wherein at least one of the image formation units includes
a pair of first stoppers disposed in the developing case, each first stopper being disposed upstream of a corresponding one of the sealing members in a rotation direction of the developer carrier, and
a pair of second stoppers, each second stopper being disposed upstream of and overlapping a corresponding one of the first stoppers in the rotation direction of the developer carrier.

2. The image forming apparatus according to claim 1, wherein the moving member is disposed below the plurality of image formation units.

3. The image forming apparatus according to claim 1, wherein each image formation unit further includes the pair of first stoppers and the pair of second stoppers.

4. The image forming apparatus according to claim 3, further comprising a pair of fourth stoppers, each disposed in contact with an end of the circumferential surface of the photosensitive member in the first direction.

5. The image forming apparatus according to claim 3, wherein each second stopper is configured to prevent the developer on the moving member from entering an image formation unit disposed downstream in the second direction.

6. The image forming apparatus according to claim 1, wherein each first stopper is disposed on a corresponding end of the developing case in the first direction, and each second stopper is fixed to an end of each first stopper.

7. The image forming apparatus according to claim 6, wherein each second stopper comprises a contact member configured to contact the circumferential surface of the developer carrier at an upstream side of a corresponding sealing member in the rotation direction of the developer carrier.

8. The image forming apparatus according to claim 7, wherein a downstream end of the contact member in the rotation direction is away from an upstream end of the corresponding sealing member in the rotation direction.

9. The image forming apparatus according to claim 1, further comprising a pair of third stoppers, each interposed between adjacent image formation units to face a lateral end of the moving member in the second direction.

10. The image forming apparatus according to claim 1, wherein the moving member includes a conveyor belt disposed facing the photosensitive members and is configured to feed a recording medium in the first direction.

11. A process unit comprising:
a photosensitive member configured to hold an electrostatic latent image on a circumferential surface thereof;
a developer carrier configured to hold a developer on a circumferential surface thereof, the circumferential surface of the developer carrier being elongated in a longitudinal direction thereof, the developer carrier disposed facing the photosensitive member;
a developing case configured to support the developer carrier;
a pair of sealing members disposed in the developing case, each sealing member being provided in a gap between the developing case and a corresponding end of the developer carrier in the longitudinal direction; and
a pair of first stoppers disposed on both ends of the developing case in the longitudinal direction, each disposed upstream from a corresponding one of the sealing members in a rotation direction of the developer carrier; and
a pair of second stoppers correspondingly fixed to the pair of first stoppers and upstream of and overlapping the first stoppers in the rotation direction of the developer carrier.

12. The process unit according to claim 11, wherein each second stopper comprises:
a contact member disposed on each end of the developer carrier in the longitudinal direction, the contact member being in contact with the circumferential surface of the developer carrier at an upstream side of a corresponding sealing member in the rotation direction of the developer carrier.

13. The process unit according to claim 12, wherein a downstream end of the contact member in the rotation direction is away from an upstream end of the corresponding sealing member in the rotation direction.

14. The process unit according to claim 11, further comprising:
a pair of third stoppers, each disposed in contact with an end of the circumferential surface of the photosensitive member in the longitudinal direction.

15. A developing unit comprising:
a developer carrier extending in a longitudinal direction, the developer carrier being configured to hold a developer on a circumferential surface thereof;
a developing case configured to support the developer carrier;
a pair of sealing members disposed in the developing case, each sealing member being provided in a gap between the developing case and a corresponding end of the developer carrier in the longitudinal direction; and
a pair of first stoppers disposed in contact with the circumferential surface of the developer carrier at an upstream side of each sealing member in a rotation direction of the developer carrier; and
a pair of second stoppers, each second stopper being disposed upstream of and overlapping a corresponding one of the first stoppers in the rotation direction of the developer carrier.

16. The developing unit according to claim 15, wherein each stopper comprises:
a contact member disposed in contact with the circumferential surface of the developer carrier, on a corresponding end of the developer carrier in the longitudinal direction.

17. The developing unit according to claim 16, wherein a downstream end of the contact member in the rotation direction is away from an upstream end of the sealing member in the rotation direction.

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